The Effect of Community Trauma on Student Achievement: Evidence from the Boston Marathon Bombing

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I. Introduction

On April 15th, 2013 two homemade pressure cooker bombs detonated near the finish line of the Boston Marathon killing five, injuring around 260 and mentally scarring hundreds of thousands more in surrounding communities. During the manhunt for the suspects that followed over the course of several days, the city of Boston essentially shut down: many were unable to work for the wages they needed, others were unable to attend religious services or have medical procedures done. Additionally, tens of thousands of children in the city of Boston and surrounding suburbs were absent from school. This type of traumatic event may have a variety of impacts on those directly and indirectly affected by the bombing.

There are two widely considered general types of trauma: direct trauma involves experiencing or observing one of these types of events firsthand or as they occur to others. Indirect trauma entails learning about the direct trauma of a close associate, such as a relative or friend. The Boston Marathon bombing was a community traumatic event that caused many people to suffer from indirect trauma.

The possible indirect effect on youth is of great interest since there is some evidence that cognitive ability is impacted by trauma. Thus, it is possible that the Boston Marathon bombing had a substantive effect on children's test score performance since the bombing took place on April 15th, 2013 and part of Massachusetts standardized test administered throughout the following month.

Moreover, the distance from the traumatic event can impact its adverse effects on individuals. For instance, sociologists have found that gun shots and crime in one community have a smaller effect on communities located further away. Similarly, the impact of the Boston Marathon bombing might have a greater effect on communities geographically close to the bombing – Copley Square in downtown Boston – than in communities outside of downtown Boston. Those in communities further from the bombing might talk about the bombing less or not worry as much about a future copycat attack. Unfortunately, little is known about the effects of the Boston Marathon bombing on youth test scores, since no studies of this even have been conducted.

This paper addresses this shortcoming in our understanding of the impact of the literature on trauma and school performance by investigating the effect of the Boston Marathon bombing on subsequent academic performance in Massachusetts. Using data on all state-wide public schools, it will evaluate: whether the bombing adversely impacted student achievement and whether this adverse impact was greater for students in schools geographically closer to the site of the bombing.

II. Literature Review

There is large literature that has analyzed the effects of indirect exposure to traumatic events. These indirect effects may be much more widespread than direct effects because of the disproportionate amount of fear and stress they generate, which might be the main reason why terrorist attacks are effective (Becker and Rubinstein 2011). These effects can become more widespread and severe because of modern technology and news outlets covering the events. Following the September 11th terrorist attacks, researchers found that the likelihood of suffering from PTSD for those indirectly effected by watching disturbing images on television increased with the number of viewings (Ahern et al. 2002). Other research on the aftermath of the September 11th attacks found that the stress symptoms of those indirectly affected by the event were similar to the expected symptoms of the survivors who were directly exposed (Suvak et al. 2008). In general, community traumatic events have been known to have negative impacts on the psychological well-being of community members and have the greatest effects on children (Margolin and Gordis 2000). Regardless of the form of the indirect exposure, the varying degrees of fearing for one's own safety is enough to influence child behavior (Beauchesne et al. 2002).

Children exposed to violence are distracted by the intrusion of thoughts related to the experience, making it challenging for them to concentrate on learning material in school, which is the main reason why their academic performance often declines (Bell and Jenkins 1991; Beland and Kim 2016). Related literature has suggested that children in schools geographically close to different community traumatic events show more signs of stress (Becker-Blease et al. 2008) and lower academic achievement (Gershenson and Tekin 2015) than children in schools geographically further away from the event. There is limited literature, however, that estimates these effects while controlling for school proximity to the event using a measure that is continuous or captured with indicator variables.

III. Theory

A. Education and Production

The idea that education is the outcome of a productive process began with the work of Gary Becker, a Nobel prize winning economist who suggested that personal productivity depends on the stock of human capital, or intangible assets, embedded in an individual, such as education and health. Becker claimed that investment in time and goods can lead to the accumulation of additional human capital, specifically in the form of education (Becker 1993).[1] Economists now commonly view educational achievement (i.e. test scores) and attainment (i.e., years completed) as the outcome of a production process. Alan Kruger notably discussed different potential specifications of education production in his study of the Project STAR experiment, which was a longitudinal study of kindergarten students randomly assigned to various class sizes (Krueger 1999). For each of these specifications, inputs can include contributions from families, the surrounding community, schools and individual attributes.

Families can influence education output in a variety of ways. Time spent and the quality of parenting throughout children's developmental stages of life can affect the children's view of

[1]Michael Grossman later developed the theory that suggested that health, too, is the outcome of a productive process (Grossman 1972; Grossman 1999)

education and, thus, their performance.[2] Parents can also serve as role models for their children via their education, occupation and relationship with them. Families can take trip to museums, national parks or other locations to provide additional education opportunities for the children. Parents also provide tangible resources such as books, writing materials and computers. Parents and siblings in the family can provide additional support to help children master lessons while at home.

Neighborhoods and the surrounding community also impact a child's education output in several ways. Just as parents can provide expectations and serve as role models for their children, other individuals in the community that do the same and inspire youths to develop their talents. Certain areas might have unique job opportunities that can provide a clear path forward to economic and social success motivating children to excel in school. Communities ravaged by high levels of crime and drug use can harm motivation and/or lessen a child's ability to focus on school (Macmillan and Hagan 2004; Finkelhor and Browne 1985; Bowen and Bowen 1999). They can also make children myopic, blinding them from the benefits of taking school seriously. Communities can also have resources, such as libraries, that are of particular value to students in increasing education output.

Schools have the power to influence education outcomes. Depth in curriculum, such as honors courses and AP classes, can keep the academically strongest children motivated and breadth of curriculum, such as arts and sports education, can motivate students who would not normally be motivated by an ordinary set of classes.[3] While the quality of teaching directly impacts students' education output, the talent of the staff and administration also influences the quality of the school itself and, thus, the education it is offering its students.[4]

School policies, such as policing systems and detention programs, affect the trust between the students and those in charge, which impact student behavior and motivation. Class size, teaching aids and other resources, such as books and computers, all also influence education output (Card and Krueger 1996). Since many of these variables are difficult to quantify, expenditure per pupil is typically used as a proxy for school quality with the assumption that the effect of schools on education output rises as expenditures per pupil rises (Card and Krueger 1992).

Finally, individual attributes that students possess can certainly impact their education output. Key inputs include ability and effort – which is influenced by attitude – as well as physical, mental and emotional health and wellbeing (Mueller and Dweck 2012). Students with more ability can learn more each day, week, month and year. For a given level of ability, those with greater focus learn more at school. Adolescents and children with superior mental and physical health are better able master school assignments and may perform relatively better in

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[2] See James Heckman's website https://heckmanequation.org/resource/parenting-capacities/ for his work supporting this theory.

[3] Altonji (1992) found a positive relationship between curriculum variety and wages and educational attainment.

[4] Koedel and Betts (2007) found that variation in teaching quality have a profound impact on student performance.

times of trouble (Currie and Stabile 1992; Singh et al. 2012). Gender could also have an impact, given that women suffer more severely from trauma than men (Olff 2017).

1. Education Production Function

Mathematically, education production as a function of its inputs can be represented in the following way:

$$Education = f(Ability\{Focus[Trauma(Proximity)]\}, X) \qquad (1)$$

where *Ability* accounts for a student's talent level and *X* represents all other inputs into education, aside from those that influence a student's ability to tap into their talent such as *Focus*. *Focus,* in turn, is altered by *Trauma* exposure and the intensity of the trauma, which is positively related to *Proximity*.

Graphically, this education production function is shown in Figure 1 in Appendix A. A common assumption is that greater ability leads to additional educational accumulation, but that the impact of ability on education is subject to diminishing returns – the first derivative is positive but the second derivate is negative. Figure 1 is drawn to incorporate this notion – the slope declines as education advances. For instance, given a fixed amount of all the of other inputs, a one unit increase in the level of ability improves education output, but at a decreasing rate as ability rises (i.e., each successive unit increase in ability leads to a smaller rise in education). In other words, the slope of the educational production function declines as ability advances.

Students' focus can fluctuate based on a variety of reasons. The presence of electronics or toys can grasp their attention at any point throughout the day along with other common distractions, but a lack of sleep, anxiety and stress can adversely influence focus more profoundly and for longer periods of time. When there is a change in the student's environment that negatively impacts their ability, for each level of ability, education output is lower and the slope is smaller, meaning the additional education output received from an equivalent increase in ability is lower. This change is shown as a rotation of the curve f_0 to f_1.

B. Trauma and Education Production

Trauma is an emotional response to a horrifying event or experience that can severely limit the brain functions associated with learning by creating stress and anxiety that reduce students' focus in class (Anda et al. 2006; Teicher et al. 2002). The education production function can be extended to capture this notion:

$$Education = f(Focus[Trauma]*Ability, X) \qquad (2)$$

where *Trauma* is exposure to trauma. The central idea is that $\frac{\partial Focus}{\partial Trauma} < 0$. Therefore, $\frac{\partial Education}{\partial Trauma} = (\frac{\partial Education}{\partial f} * \frac{\partial f}{\partial Focus} * [Ability \frac{\partial Focus}{\partial Trauma}]) < 0$. This can be depicted by a downward rotation of the educational production function as shown in Figure 1.

1. Children, Trauma and Education

Children's individual attributes contain the inputs into education output that are most likely to be affected by trauma. Those directly impacted by the traumatic event might suffer physical injuries that prevent them from attending school, focusing on their work or both. Indirect trauma can lead to declines in mental health, resulting in a poorer proficiency for children to concentrate following a traumatic event. The trauma could also weaken a child's attitude and motivation towards learning.

Trauma can alter other inputs – families, schools, and communities – in the education production process and, hence, exacerbate or buffer the impact of trauma on educational output. When a traumatic event occurs, families often provide the more resources to help their children cope with the trauma. Some parents might give their children more of their time, attention and empathy to comfort them, all of which could improve the parent-child relationship. Other parents might give their children physical items, such as toys or video games to help their children get their minds off of the traumatic event. These methods of dealing with trauma will all decrease – buffer – the impact the trauma has on the child.

2. Schools, Trauma and Education

Schools can reflect a variety of developments that can affect educational output following a traumatic shock. Extreme degrees of trauma can shut down schools. If schools remain open, they can provide children with a safe place where they feel comfortable to focus and learn. Trauma can also affect teaching ability if the teachers are also impacted by the trauma. However, most school inputs in education output are likely unchanged following a traumatic event. These variables include, depth and breadth in curriculum, tangible resources, such as books and computers, class size and school policies.

3. Communities, Trauma and Education

Finally, inputs in education output from communities can be influenced by trauma. If a traumatic event occurs directly within a community, children might not be able access their role models in the neighborhood or community resources such as public libraries, museums and parks. It is unclear whether trauma will positively or negatively impact crime rates and drug use. It is possible that trauma increases crime rates in a community because criminals might try to take advantage of the community when it is physically and mentally weak. On the other hand, criminals, themselves, might be traumatized as well, which could result in either an increase or decrease in their criminal activity depending on their own attributes and personal responses. A standard assumption is that community contribution to educational attainment is expected to be larger in more affluent communities – places where fewer students qualify for free or partially subsidized lunch. For simplicity, it is assumed that following a traumatic event, community inputs to the production of education are unchanged whether a school is located near or far from the site of the event.

4. Modelling Trauma and the Education Production

Figure 2 displays the theoretical effect trauma is expected to have on education output. When a traumatic event occurs, any of the above scenarios could come into play and rotate the education production function curve downward from f_0 to f_1. Which inputs and to what extent that they are impacted, however, will dictate just how large the rotation in the curve will be. For example, parents could give their children all their time and attention to try to comfort them and – in theory – eliminate the possibility of any negative effects of trauma on schooling; however if their child suffers extremely poor mental health as a result of the trauma, their focus will still be severely impacted – harming their education output despite greater parental efforts.

IV. The Boston Marathon Bombing and Education Production

The Boston Marathon bombing is an example of a traumatic event that likely impacted education by affecting an individual's capacity to focus on their schoolwork. However, the adverse effect of this trauma on a students' concentration is likely to depended on time relative to the occurrence of the event, since alterations in brain function associated with the event will evolve over time. In economics, time is usually malleable but with certain restrictions; the short run is typically defined as the period of time when all inputs are fixed, the medium run is normally defined as the period of time when only some inputs are fixed. The convention is for the long run to be characterized as the period of time when no inputs are fixed. These definitions are all conceptual, however. In reality most time effects are ad-hoc stipulations to guide empirical investigations. For example, although short-run unemployment occurs when labor force participants are out of work for 16 weeks or less, surely several inputs that influence unemployment are not fixed over 16 weeks. Thus, the effects described below do not follow the standard definitions of economic theory but are rather defined to accurately explain the likely effects of trauma that differ depending on the time period.

The Massachusetts Comprehensive Assessment System (MCAS) mathematics exam is a standardized test administered in Massachusetts public schools annually, so the short run, or first-period, in this analysis is the period of time between the exam date in 2012 and 2013. The second period, defined as the intermediate run, is the period of time between the 2013 exam and the 2014 exam date. The third and final period, defined as the long run, is the period of time between the 2012 exam date and the 2014 exam date.

A. Short Run Effect

The Boston Marathon bombing is expected to result in trauma for youth's capacity to focus at school, leading to a negative short run effect on exam performance, since the exam was administered only a few weeks after the bombing. Given the short period of time from the bombing to the exam, I suspect that most other inputs in the educational production function are either unchanged or adjust to a much smaller extent than the changes in children's concentration. In essence, the child effects of the trauma exposure dominate all other effects in the period immediately following the trauma up to the administration of the exam.

Despite the supportive environments both at home and school that attempt to comfort children to reduce the effects of trauma, the effect of trauma on the individual is likely detrimental to academic performance. It is logical for students to think that since the event happened once it can certainly happen again, and they are unsure when. Both the stress from a traumatic event and the uncertainty of re-occurrence increases amygdala functioning, which is responsible for generating fear responses in accordance with the prefrontal cortex (Teicher et al. 2002). Fearful students are less able to focus in class, which is expected to reduce their test scores (Bremner 2008). Trauma also affects the hippocampus, which is very sensitive of the effects of stress and whose main function is short- and long-term memory, which is central to learning (Bremner 2008; Teicher et al. 2002). Thus, damage to the hippocampus in students brains undermines their ability to retain information in school and recall it when needed, therefore, reducing academic performance.

1. Proximity and the Short Run Effect

The intensity of the effect of trauma might not only depend on elapsed time since the trauma occurred but also proximity to the traumatic event. For the Boston Marathon bombing, the effects of trauma in the short run might vary based on how close the student was to the bombing with those closest to the bombing suffering the most. The education production function can be modified again to account for this:

$$Education = f(Focus[Proximity*Trauma]*Ability, X) \qquad (4)$$

where *Proximity* is the distance from the bombing and reflects the intensity of the impact of *Trauma* on *Focus*. For instance, now the effect of an increase in trauma would be $\frac{\partial Education}{\partial Trauma} = \frac{\partial Education}{\partial f} * \frac{\partial f}{\partial Focus} * [Proximity * \frac{\partial Focus}{\partial Trauma}] < 0$. Note that if *Proximity* is large – the student's school is close to the site of the bombing – then the adverse impact of the bombing on educational production is much greater than if *Proximity* were small (i.e., the student's school is located at a greater distance from Copley Square).

Figure 2 depicts how the education production function may vary for students of different proximities from the bombing. While students far from downtown Boston might experience no effect at all, *Proximity* is very small, a student in downtown Boston might experience the most intense effect, *Proximity* is large leading to a greater negative impact. This is shown as the largest rotation in the curve from f_0 to f_2 because of their close proximity to the bombing. As a result, the close student's education output drops to E_2 ceteris paribus.

Students in the suburbs of Boston might still feel the short run effect, but its intensity might not be as severe since they are slightly further away from the bombing. The education output for these students, E_1, settles in between that of the students close to and far from the bombing.

B. Intermediate Run Effect

These short run effects of trauma on the brain could fade away over time. If there is no additional impact of the trauma during the subsequent year, then the total – combined – effect of trauma would be limited to the short run effect. However, the bombing is also expected to have a negative effect on exam performance in the intermediate run which is measured by a student by test performance in 2014 relative to 2013 (i.e., the year of the bombing).

According to the America Psychiatry Association, post-traumatic stress disorder (PTSD) is an anxiety disorder that can occur in people following an experience of witness of a traumatic event with symptoms including "intense, disturbing thoughts and feelings related to their experience that last long after the traumatic event has ended." Previous research has found that those who suffer from PTSD begin to show symptoms more than six months after the traumatic event, and the duration of symptoms depends on the severity of the event and the stress tolerance of the individual (Utzon-Frank et al. 2014; Iribarren et al. 2005). Memories of the traumatic or stressful events are likely what triggers the symptoms of PTSD (Bisson 2015). Thus, the effect from PTSD, all else the same, would not show up in the 2013 test results since the test was administered only one month after the bombing; rather, the trauma from the Boston Marathon bombing might foster PTSD fostering a negative impact on concentration at school – and hence exam performance – in the subsequent year. An interesting question is how likely is it that events, such as anniversary discussions, will transpire that lead to revisiting of the Boston Marathon Bombing, and hence PTSD, of the event?

The moments of the traumatic event are in the public's conscious and are often revisited during the anniversaries of the event. Just as newspapers across the country are filled with articles on 9/11 each year, newspapers in Boston started to recall the tragic scene that devastated the city one year later. Not only did the Boston Globe put out articles filled with personal recollections from the victims of the bombing (Lazar 2014), but its staff on the one-year anniversary of the bombing received a Pulitzer Prize for how they handled the moments after the bombing (Finucane 2014). By revisiting the trauma in this fashion, one can image the PTSD and a decline in focus leading to an intermediate run decline in educational performance. Thus, it is likely that some youth experienced a delayed – PTSD – effect on school performance from the Boston Marathon Bombing.

1. Proximity and the Intermediate Run Effect

The intensity of the intermediate run effect, like the short run effect, is also expected to depend on proximity. Those far from the bombing again might not experience much of a PTSD effect, but those closer to bombing are expected to be exposed to more events that revisit the bombing leading to a greater level of PTSD and, thus, an adverse intermediate run effect.

Children in the suburbs, however, might experience a more severe intermediate run effect compared to those in downtown Boston. Due to their proximity to the bombing, students in downtown Boston might suffer from severe trauma from the event right away as explained by the short run effect. Having lived with the trauma for a full year, the one-year anniversary ceremonies and remembrance of the city of Boston might not trigger as substantial a set of PTSD symptoms as they may for those in the suburbs who likely have not had as much exposure and memory of the bombing. Essentially, students who reside inside the city of Boston have been living with the issue all year and the law of diminish returns has set in extensively for them. Any additional discussion is likely to have little effect. This may not be the case for those in the suburbs.

Furthermore, family socioeconomic status is greater for families living in the suburbs. It may well be the case that parents and teachers of students in the suburbs will go out of their way to protect their children, promoting their emotional well-being and learning by discontinuing focus or discussion of the event. However, this may not be possible on the one-year anniversary. of an extremely traumatic event like the Boston Marathon bombing. Perhaps this protection is less effective or wears off after a certain period of time or just is not prevalent during the one-year anniversary events. Thus, it could be as if children living in the suburbs of Boston are experiencing the trauma from the event for the first time. If this were the case, the expected drop in education output in the intermediate run is more severe for students in the suburbs than students in downtown, as depicted in Figure 3. Note that in Figure 3, for a given ability level, education output in the intermediate run remains the same at E_0 for students far away from the bombing. However, education falls drastically – from E_0 to E_2 – for students in the suburbs and drops less severely – from E_0 to E_1 – for students attending school in downtown during the intermediate run.

C. Long Run Effect

There are many ways to experience a long run effect depending on the presence or absence of short and intermediate run effects. Some students might experience a short run effect that decreases scores, or the rate of increase in scores, from 2012 to 2013. Moreover, they may have suffered an intermediate effect that decreases scores from 2013 to 2014. In this situation the combined or long run effect could represent the permanent footprint that the trauma from the bombing left on some students – which is a decline in educational output. To help disentangle the range of possible long run – permanent – effects on education caused by the Boston Marathon bombing, a matrix, Figure 4, is utilized. The columns in Figure 4 represent the two possible outcomes for the short run and the rows present the two potential scenarios for the intermediate run – for both, there is either an adverse effect or no effect. The long run effect is the combination of these two effects.

If there is no short run effect and no intermediate run effect, there is no long run effect. This potential outcome is identified visually as the bottom right box of Figure 4.

If there is a short run effect but no intermediate effect, there will likely be a modest negative long run effect. For example, maybe students are so impacted by the trauma in the short run that, although their scores increase the following year suggesting no intermediate effect, they increase at a slower rate or never recover to as high as they were before the traumatic event. Similarly, no short run effect but a negative rebound effect in the intermediate run leads to a negative long run effect – smaller than the decline in schooling resulting from both a negative short and intermediate run experience. In this case students possibly never heard much about the bombing when it occurred, but when they did one year later, the impact was devastating, and their test scores experienced a similar decline. Students in both situations could also experience either a short run or intermediate run effect, but fully recover and, thus, experience no long run effect. These scenarios are outlined in the bottom left and top right boxes in Figure 4, respectively.

Finally, if both the short run and intermediate run effects are present, there is likely a substantial negative long run effect, shown in the top left box of Figure 4. In other words, rather than suffering from the trauma for a period of time and recovering or experiencing a lag in symptoms of PTSD, students might immediately start to feel the short run effect and then never recover before the intermediate effects kick in, which also diminishes learning. As a result, these students suffer from what appears to be a permanent negative effect on education output.

1. Proximity and the Long Run Effect

The effects in the short run and the intermediate run likely differ by proximity groups. As previously noted, the impact the trauma will have in the short run will be greater for those closer to the bombing. Thus, as seen in the lower left box of Figure 4, the potential long run effect is greater for those in higher proximity schools when there is a short run effect but no intermediate run effect. Similarly, in the intermediate run the trauma will have a greater impact on those in the suburbs. Hence, as displayed in the upper right scenario of Figure 4, the potential long run effect is greater for those in lower proximity schools – further from the bombing – when there is an intermediate run effect but no short run effect. The graphical depictions of these two long run effect outcomes are the same as the figures that display the short and intermediate run effects; that is, Figure 2 which shows the short run effects for the different proximity groups displays the long run effect with no intermediate effect. Likewise, Figure 3, which shows the intermediate run effects for the different proximity groups portrays the long run effect if there is no short run effect. Of course, if there were no short run effect and no intermediate run effect, there would be no rotation, and education production would remain along the curve f_0 shown in Figures 2 and 3.

Figure 5 shows the expected results from the long run effect graphically for different proximity groups in the situation when there is both a short run and intermediate run effect. Again, for students far away from the bombing, it is likely that neither the short run nor the long run effects will reach them, so their education production function remains at f_0 and their education output stays at E_0. Assuming that students in downtown Boston experience the short run as well as the intermediate run effect, and students in the suburbs experience not only the intermediate effect but also the short run effect, both groups' education production function is expected to drop down to f_1 where their education output falls all the way to E_2. The value of education output at E_1 is lower than the downtown group's value after the short run effect and the suburbs group's value after the intermediate effect. Thus, the graph shows that long run effect not only leaves a permanent footprint on the education output for both groups, but that effect is greater than the short run and intermediate run effects alone.

In summary, a negative long run effect is most likely for students in the Boston area – both downtown and in the suburbs – due to the expected short and intermediate run effects. The group that experiences a larger effect, however, is unclear because of the uncertainty around the magnitude of these effects. Students outside of Boston are most likely to experience no adverse effect on educational output in the long run.

V. Data

A. School Performance

The Massachusetts Comprehensive Assessment System (MCAS) is a three-part standardized test administered by the Massachusetts Department of Education (MDOE) to students in Massachusetts public schools at different times throughout each school year. The mathematics subject test is administered in May every year, so only this test was used – to evaluate the impact of the Boston Marathon bombing on educational production – to avoid delayed and inconsistent effects from the other two tests. For example, since the English Language Arts exam is administered in March every year, if the results of this exam were included, the first year of data following the bombing would have been found in March 2014 – 11 months later. Thus, there would be no way to identify the potential presence of a short run effect. Only students in grades 3-8 and 10 take the math subject test.

Data was gathered for the 2010-11 through 2014-15 academic years. The MDOE breaks down the percent of students in each public school that correctly answered each question by test, grade level and year. Averaging these percentages by grade level, then school, then year using the number of students at each school as weights, the average score per school year was obtained. This value is the measure used as the dependent variable in the empirical work.

B. Distance

Using geographic coordinates of each Massachusetts public school during the 2012-13 academic year from the National Center for Education Statistics (NCES), distances between each public school and Copley Square, the site of the bombing in downtown Boston, as the crow flies were calculated. Those schools classified as *Downtown*, *Suburbs* and *Outside* were within 10, between 10 and 35 and outside of 35 miles of Copley Square, respectively. Measuring distance in this way is the key independent variable of interest.

C. Controls

Within the MDOE database are other useful datasets including total expenditures and expenditures per pupil at the district level. This information allows us to account for the effect of school quality on educational performance. The NCES was also used to gather the percent of students on free lunch programs for each year – a standard measure of family socioeconomic status, another likely determinant of school performance. Moreover, the NCES provides information for each school's enrollment including percent of students by race, gender and grade level.

For each grade expenditure per student and share of students on subsidized lunch were each divided into three different binary categories: low, medium, and high. For each year the 33rd and 66th percentiles of average expenditures per pupil and percent on free lunch were calculated. Schools were considered low expenditures per pupil if their value was less than the value of the 33rd percentile, mid expenditures per pupil if their value was between the values of the 33rd and 66th percentiles and high expenditures per pupil if their value was greater than the value of the

66th percentile. Categorization in this manner was performed for each year. Thus, a school could be considered low expenditure per pupil in one year but mid or high expenditure per pupil in another year based on a large enough shift in the school's expenditures or enrollment or those of enough other schools, which would shift the value of the 33rd percentile.

The same method was used to categorize schools into low, mid and high variables for each year for each of the free lunch, race and gender controls. For example, the 33rd and 66th percentiles of students on free lunch programs were calculated for each school each year; then, low, mid and high values were calculated based on these values. For simplicity, grades 3-5 were considered *Elementary School*, grades 6-8 were considered *Middle School* and grade 10 was considered *High School*.

D. Summary Statistics

Appendix B contains tables and figures of the unconditioned data for each variable used in the empirical work.

1. Test Scores

Panel A in Table 1 details the summary statistics of the average test scores, the dependent variable. The number of observations here represents the number of unique schools that provided test score information per year. The changes in schools between years shows the difference between the number of schools that opened and the number that closed over the last year. The decline in schools in 2015 is due to the limits of MDOE's ability to collect and organize every school's test score data in a timely manner. Figure 1 in Appendix B shows the trend in scores over the five-year period described in Table 1. Average scores ranged from about 70.5% to just over 73% with the biggest jump occurring between 2012 and 2013. This large spike in scores at first suggests the absence of a short run effect; however, this figure pools information from all types of schools located all across Massachusetts. It is possible that only a select group experiences a short run effect that is overshadowed by the increases in scores by those unaffected. For this same reason the decline in unconditioned scores from 2013 to 2014 should not yet be interpreted as an intermediate run effect.

2. Proximity

Panel B in Table 2 shows the summary statistics for the distance variable that measures the number of miles from site of the bombing. Panel C breaks this distance variable into its three categorical variables: *Downtown*, *Suburbs* and *Outside*. The number of observations in Panel C show just how many schools were within each proximity level each year. Figure 2 shows the breakdown in scores per year for these three proximity categories. Clearly, schools in the Boston suburbs perform the best and schools in downtown Boston perform the worst except for 2015, during which scores might be heavily influenced due to the small sample size. This difference in the unconditioned scores between *Downtown* and *Suburbs* could be because of the differences in socioeconomic status between those that live in downtown and those that live in the suburbs. In fact, every school in cities and towns in Massachusetts with per capita income above $70,000 fell into the “near” bucket that identifies the Boston suburbs. Meanwhile, several of the state’s most impoverished areas are located downtown.[5]

3. Controls

Table 3 presents the summary statistics for the control variables. Panels A and B reveal the statistics for number of students on free lunch programs and average expenditure per pupil by school for each year, respectively. The number of students enrolled in free lunch programs hovers right at or just above 30% for each year and average expenditures per pupil experience yearly increases likely due to inflation except for 2015. Because of the limited observations in 2015, it is difficult to know why this is the case. These controls are of particular interest because they are used to gauge potential school and community effects.

i. Community Effects

Figure 3 shows the trends in math test scores for low, mid and high free lunch schools. Although all three categories experience increases in scores in 2013, it appears that as the percent of students on free lunch decreases, that increase becomes flatter. This means that students in schools with low percentages on free lunch might experience more of a short run effect – their scores increased at a smaller rate – than those in schools with high percentages on free lunch. Perhaps schools with low percentages of students on free lunch are located in neighborhoods of high socioeconomic status. Hence, the parents of these students are more educated and might spend more time discussing the traumatic event with their children leading to a more trauma and a smaller increase in scores relative to students in other schools in the short run. On the contrary, those attending schools with a high percentage of free lunch students might live in households that spend less time discussing the bombing since other, more immediate obligations like putting food on the table are more important to them. Therefore, the trauma is less impactful for these children leading to a rise in test scores in 2013.

Figure 4 breaks this chart down even further into each of the proximity groups. The difference in size of the increase in scores from 2012 to 2013 between low and high free lunch schools seems to be the largest in the suburban schools, which have been noted to be the wealthiest in the state. The high free lunch group experiences a big increase in scores from 2012 to 2013 while the low free lunch group, representing schools in wealthier neighborhoods, experiences a minimal increase. This observation suggests that only students in the wealthier neighborhoods of the suburbs experience a short run effect that undermines learning as represented by math test scores.

ii. School Effects

[5] Source: US Census Bureau

Differences in average scores between schools of low, middle and high expenditures pupil are shown graphically in Figure 5. Schools in the bottom third of expenditures per pupil perform the best every year, an observation that goes against the theory that schools with higher expenditures yield higher student test scores because they pay for more resources. This could be due to programs aimed to improve student performance in lesser resourced schools. Figure 6 breaks the expenditures per pupil graph into the three proximity categories and, upon observation, it is not yet clear if there are any effects in the short, intermediate or long run for schools of different expenditure levels even when broken down by proximity.

iii. Other Controls

Panel C in Table 3 shows the average grade for each level and how many of each school type are included in the dataset for each year. The average every year for the *High School* variable is 10 because 10^{th} grade is the only high school grade included – since the math MCAS test is not administered to higher grades. Panels D and E present the statistics for subsamples based on race and gender, respectively. Each year whites populate around $2/3^{rds}$ of a school on average and about 8% of total enrollment is black on average. Gender appears to be nearly a 50-50 split with females holding around 49% on average each year.

VI. Empirical Strategy and Results

A. Difference Model

The following models are used to estimate the various effects of the trauma generated by the Boston Marathon bombing on the outcome of interest – educational achievement on the math test in Massachusetts public schools. Our focus is on the effect of proximity to the bombing across the three periods of analysis.

1. Short Run Effect Model

In the short run it is expected that the bombing would have a negative effect on school performance in the first year after the bombing and that this effect would be greatest for students within downtown Boston. The following model is used to evaluate this hypothesis:

$$(2013\ Score - 2012\ Score) = \beta_0 + \beta_1{*}Downtown + \beta_2{*}Suburbs + \beta_3{*}X + \varepsilon \qquad (5)$$

where (*2013 Score – 2012 Score*) is the difference in average scores at the school level from 2012 to 2013. X is the set of control variables including measures to account for community effects, school effects, race, gender and grade level while ε is the error term. Given this specification the reference group is *Outside* – schools located further from Boston than the suburbs. The short run proximity hypothesis predicts that both β_1 and β_2 will be negative – student attending schools closer to the site of the bombing experience larger declines – or smaller improvements – in learning. Educational performance is also expected to be more adversely affected in the short run for students closer to the site of the bombing – those in downtown schools compared to those attending suburban schools – resulting in $|\beta_1| > |\beta_2|$.

2. Intermediate Run Effect Model

In the intermediate run it is expected that the bombing would have a negative effect on school performance in the second year after the bombing; this effect would be greatest for students in the Boston suburbs where the anniversary of the event creates renewed discussion and PTSD to a greater extent due to families in this location more intensely revisiting the trauma. The following model is specified to evaluate this hypothesis:

$$(\text{2014 Score} - \text{2013 Score}) = \beta_0 + \beta_1{*}Downtown + \beta_2{*}Suburbs + \beta_3{*}X + \varepsilon \qquad (6)$$

where (*2014 Score – 2013 Score*) is the difference in average scores at the school level from 2013 to 2014, while X is the same set of control variables in equation (5) and ε is the error term. The intermediate run proximity hypothesis predicts that β_1 and β_2 will both be negative – scores will be more adversely impacted in schools in downtown and the suburbs of Boston, but with the greatest effect in suburban schools leading to $|\beta_2| > |\beta_1|$.

3. Long Run Effect Model

In the long run it is expected that the bombing would have a lasting negative effect on school performance two years after the bombing. It is unclear whether this effect will be greater for students in downtown Boston or in the Boston suburbs. The following model evaluates this potential effect:

$$(\text{2014 Score} - \text{2012 Score}) = \beta_0 + \beta_1{*}Downtown + \beta_2{*}Suburbs + \beta_3{*}X + \varepsilon \qquad (7)$$

where (*2014 Score – 2012 Score*) is the difference in average scores from 2012 to 2014. X is the same set of control variables described above and ε is the error term. The long run proximity hypothesis predicts that β_1 and β_2 will both be negative, but it does not predict whether $|\beta_2| > |\beta_1|$, $|\beta_2| < |\beta_1|$ or $|\beta_2| = |\beta_1|$.

B. Difference Model Results

Table 1 in Appendix C presents the results of the three difference models described above that estimate the effects of the proximity variables on the differences in scores from 2012 to 2014.

1. Proximity Effects

i. Short Run Effect

Table 1, column 1 presents estimates of the differences in scores from 2012 to 2013 – the short run effect. Inspection of column 1 reveals that from 2012 to 2013 average scores were almost a quarter of a percent lower for schools in downtown Boston and just slightly lower for schools in the Boston suburbs both relative to schools outside of Boston – as predicted by the short run proximity hypothesis; however, neither is statistically significant at conventional levels.

Thus, there is no strong evidence that the short run effect of the Boston Marathon bombing is more damaging for students located closer to the site of the bombing as hypothesized.

ii. Intermediate Run Effect

The intermediate run effect, the differences in scores from 2013 to 2014, are displayed in column 2. The positive coefficients on the *Downtown* and *Suburbs* variables mean that schools in these areas experienced an increase in scores from 2013 to 2014 relative to the change in scores over this period for schools *Outside* of the Boston area. These results appear to contradict the hypothesized intermediate run – rebound effect via PTSD – effect; however, neither result is statistically significant. In essence, the evidence suggests that proximity to the bombing was unrelated to performance on the math test one year out from the trauma.

iii. Long Run Effect

Column 3 shows the estimates of the differences in scores from 2012 to 2014, the long run effects. The negative coefficients on the values for the *Downtown* and *Suburbs* variables suggest that educational performance on the math test over this more expansive period is poorer in schools close to Boston or in Boston proper; however, neither is statistically different from zero at standard levels. Therefore, there is no convincing evidence to support the hypothesis that students closer to the bombing experienced a more pronounced long run decline in math test scores.

2. School Effects

i. Short Run Effect

It is possible that the effect of the Boston Marathon bombing on student performance on the math exam were influenced by the stature of the schools, gauged by the level of resources per student.

Schools in the lowest and highest expenditures groups of schools experienced a decrease in math scores from 2012 to 2013 relative to the middle group. Students in the lowest expenditure per student schools scored 0.42 percentage points lower, and this result is slightly statistically significant. This finding is consistent with the short run hypothesis. One possible explanation for this finding is that schools with lower expenditures do not have the resources to provide students with as much emotional support – or to ensure that they are ready to take the exam in the following month.

Students in schools in the high expenditures also see a decline in scores from 2012 to 2013 relative to the middle group. This result is surprising, since greater resources should buffer the adverse impact on school performance of the Boston Marathon bombing in the short run; however, it is not statistically significant. Therefore, the evidence suggests that there is no meaningful difference on test performance for youths attending medium and high resource schools.

ii. Intermediate Run Effect

The negative estimate on the *Low Expenditures* variable suggests that those in schools with low expenditures per pupil experience a decrease in test scores from 2013 to 2014 – relative to the medium resource schools. This supports the idea that the rebound or PTSD effect is greater in poorer schools, which is unexpected, and, therefore, supports the intermediate run effect hypothesis. The positive estimate on the *High Expenditures* variable also supports the hypothesis and the theory that higher expenditures leads to greater academic performance. Neither value, however, is statistically significant, so there is no evidence supporting the idea that school resources mediates the intermediate run effect.

iii. Long Run Effect

The estimates the *Low Expenditures* variable is negative, suggesting the existence of a long run effect for these schools, but the value is statistically insignificant. The same is true for the positive value for the *High Expenditures* variable. Thus, the data does not support the speculation that the bombing impacted schools of various rates of expenditures per pupil differently in the long run.

3. Community Effects

i. Short Run Effect

Parents from poor communities face a number of insecurities – housing, transportation, employment, food and day care – that lead to worries and effort to address these concerns. As a result, they have less time and energy to allocate to the education and support of their children relative to more resourced families. Thus, they may be less able to buffer the effects of a trauma on their children.

Schools with low percentages of students on free lunch programs, relative to schools with around the average level of percent of students on free lunch programs, did about 1.15 percentage points worse on the math test between 2012 and 2013. This statistically significant result supports the theory that the short run effect has a greater negative impact at schools in higher socioeconomic status neighborhoods. Students living in these neighborhoods might experience a short run effect because their parents are likely to have more education and, thus, might be more inclined to discuss the event around the house within earshot of – or with – their children. Schools in neighborhoods of lower socioeconomic status represented by high percentages of students on free lunch did 0.271 percentage points better than those with average levels of free lunch students. This suggests that students in average socioeconomic communities were harmed more in the short run by the bombing trauma than kids from poorer communities. This could be because the parents of students in low resourced communities are less educated and have so many pressing insecurities to worry about in their lives that they do not spend much time with their children discussing the Boston Marathon bombing.

ii. Intermediate Run Effect

Schools with low and high percentages of students on free lunch programs experienced increases in scores from 2013 to 2014, going against the theory that the intermediate run effect differs by the socioeconomic status of the community. It seems that, after experiencing a short run effect one year earlier, those in low percent free lunch schools including students typically in wealthier communities have recovered from the traumatic impact of the bombing. This result is statistically significant, so the data supports this idea; however, those in high percent free lunch schools have now experienced two straight years of increases in scores, suggesting that the trauma has no effect on their academic performance. This result, however, is not statistically significant meaning there is no convincing evidence that schools with high percentages of students on free lunch suffered any differently from the bombing in the intermediate run compared to students in schools with average percentages on free lunch.

iii. Long Run Effect

The negative and statistically significant estimate reported in column 3 of Table 1 reveals that children attending schools with low percentage of students on free lunch programs also experienced a greater long run effect than those in schools with the average percentage of students receiving subsidized lunch. For this group, however, rather than experiencing a stronger intermediate effect and no short run effect, the negative short run effect overpowered the absence of an intermediate run effect. In other words, it is likely the case that students in these schools struggled with the trauma from the bombing severely right after it happened and, although their test scores improved the next year, they did not improve enough to recover the loss in achievement from the previous year. This is a striking finding.

4. Controls

Estimates of the differences in the short, intermediate and long run effects by grade level, race and gender are also reported in Table 1 of Appendix C.

C. Robustness to Dependent Variable Measure: Math Score Level

Another way to evaluate the effect of the bombing is to investigate the effect of proximity of the school to the bombing on the level of the math test score in a particular year, rather than the difference in test scores for each of the three periods. While the previous difference model presented estimates as changes in scores for each group relative to changes in scores for the reference group, this model would detect the difference in actual scores between the variable of interest and the reference group for each year. The impact of school proximity on the level of math scores also may be mediated by a range of factors, such as neighborhood wealth or school resources.

1. Additional School Effects Model

To evaluate if the effect of proximity to the trauma on math test scores varies due to differences in school resources, the following model is estimated:

$$Score_t = \beta_0 + \beta_1 * Downtown + \beta_2 * Suburbs + \beta_3 * Low\ Expenditures_t + \beta_4 * High\ Expenditures_t + \beta_5 * (Downtown \times Low\ Expenditures_t) + \beta_6 * (Suburbs \times Low\ Expenditures_t) + \beta_7 * (Downtown \times High\ Expenditures_t) + \beta_8 * (Suburbs \times High\ Expenditures_t) + \beta_9 * X + \varepsilon \quad (8)$$

where $Score_t$ is the average score in year *t*, $Low\ Expenditures_t$ and $High\ Expenditures_t$ are the low and high categories for expenditures per pupil for year *t*, ($Downtown \times Low\ Expenditures_t$), ($Suburbs \times Expenditures_t$), ($Downtown \times High\ Expenditures_t$) and ($Suburbs \times High\ Expenditures_t$) are interaction terms between the proximity categories and the low and high expenditure per pupil variables, *X* is the rest of the control variables and ε is the error term. The proximity reference group is still *Outside* – further away from the bombing than the suburbs. *Mid Expenditures*, representing the schools in districts around the average level of expenditures per pupil, is the reference group for *Low Expenditures* and *High Expenditures*. For this specification the impact of attending schools located in downtown Boston is

$$\frac{\partial Score}{\partial Downtown} = \beta_1 + \beta_5 * Low\ Expenditures_t + \beta_7 * High\ Expenditures_t. \quad (9)$$

Thus, the estimated effect on math scores for a student in average expenditure per student schools located in *Downtown* – relative to students located *Outside* of the Boston area that are average expenditure per student schools (i.e., the reference group) – is β_1. The math score of students who attend *Downtown* schools that are *Low Expenditures* is $\beta_1 + \beta_5$ while the scores for those attending *Downtown* schools with *High Expenditures* is $\beta_1 + \beta_7$. Essentially, the estimated interaction term reveals the additional impact on test score for schools that fall into that particular category.

2. Additional Community Effects Model

Proximity might also be mediated by the socioeconomic status of the community. For example, the difference in the effect on wealthier neighborhoods compared to poorer neighborhoods might be greater in the suburbs than in downtown. The following model that interacts proximity with the free lunch binary variables is used to estimate if the effect of proximity to the trauma varies due to differences in community wealth:

$$Score_t = \beta_0 + \beta_1 * Downtown + \beta_2 * Suburbs + \beta_3 * Low\ \%\ Free\ Lunch_t + \beta_4 * High\ \%\ Free\ Lunch_t + \beta_5 * (Downtown \times Low\ \%\ Free\ Lunch_t) + \beta_6 * (Suburbs \times Low\ \%\ Free\ Lunch_t) + \beta_7 * (Downtown \times High\ \%\ Free\ Lunch_t) + \beta_8 * (Suburbs \times High\ \%\ Free\ Lunch_t) + \beta_9 * X + \varepsilon \quad (10)$$

where $Score_t$ is the average score in year *t*, $Low\ \%\ Free\ Lunch_t$ and $High\ \%\ Free\ Lunch_t$ are the low and high categories for expenditures per pupil for year *t*. For this model the impact of attending schools located in downtown Boston is

$$\frac{\partial Score}{\partial Downtown} = \beta_1 + \beta_5 * Low\ \%\ Free\ Lunch_t + \beta_7 * High\ \%\ Free\ Lunch_t. \quad (11)$$

Hence, the estimated effect on math scores for a student in average free lunch schools located in *Downtown* – relative to students located *Outside* of the Boston area that are average free lunch schools (i.e., the reference group) – is β_1. The math score of students who attend schools in *Downtown* that are *Low % Free Lunch* is $\beta_1 + \beta_5$ and scores for those in *Downtown* schools that are *High % Free Lunch* is $\beta_1 + \beta_7$.

D. Level Effect Model Results

1. School Effects

The coefficient estimates on all four interaction terms from 2012 to 2014 reported in Table 2 are positive, but insignificant. Thus, there is no evidence to support the idea that the Boston Marathon bombing affected schools of varying expenditure levels differently in alternative locations relative to the site of the bombing. This set of findings is at odds with the hypothesis that school resources have a mediating impact on proximity.

2. Community Effects

Table 3 displays the regression results of the additional community effects model.

i. Downtown

There is no evidence that supports the theory that the Boston Marathon bombing impacted students differently based on their proximity to the bombing and the socioeconomic status of their neighborhood.

ii. Suburbs

For the communities in the Boston suburbs, it is fascinating to note the decrease in magnitude of that additional effect in 2013, the year of the bombing, for wealthier suburban neighborhoods characterized by schools with low percentages of students on free lunch. Due to the community wealth in these areas, schools likely have excess resources and, thus, their students perform the best of any schools in Boston year after year; however, it is possible that the bombing could generate this decrease in the additional effect, lowering the premium in scores these students have over others despite their excess access to resources because they suffered more from the trauma of the bombing. The fact that this decline in the estimate occurs in 2013 but returns to about its previous value in 2014 support the idea that short run effect differs by neighborhood wealth in the Boston suburbs, but not for the intermediate or long run effects. Thus, the data suggests that students in wealthy neighborhoods in the Boston suburbs suffered more substantially from the trauma of the Boston Marathon bombing in the short run. Mixed and insignificant trends are observed for schools in Boston suburbs with high percentages of students on free lunch programs likely due to a small sample size in these areas.

3. Controls

See Tables 4-9 to see the additional effects models for each of the other control variables including grade, race and gender.[6]

VII. Conclusion

This paper evaluates the hypothesis that the Boston Marathon bombing was such a traumatic experience for youth living in Massachusetts that it harmed their math standardized test scores and that this effect was larger the closer the school to Copley Square – the site of the bombing. The evidence reveals that the short run effect exhibited in the difference model for all schools of low percentages of students on free lunch suggests that students in these schools are indeed traumatized by the Boston Marathon bombing – a traumatic event. Moreover, this effect is greatest for the wealthiest suburban communities. It could be the case that parents and teachers in this group think that they help their children when they discuss the bombing with them directly. Perhaps, instead, they do not even intend for the children to listen to their conversations about the bombing, but because of their own backgrounds, they cannot help but think about the repercussions of the bombing more than those in communities of lesser socioeconomic status. Further research should look into how parents and teachers addressed the bombing with their children – conversations, watching television showing the bombing, etc. – and the extent relative to families located in other communities.

Students were expected to experience a greater adverse impact if they attend schools close to the site of the bombing, but no evidence is found to support any of the three proximity theories – short, intermediate and long run effects. Because the data is pooled at the school level, it might not pick up on these effects. For this reason, the findings in this paper could be subject to measurement error. Instead of using the average score by each school, it would be ideal to have data at the individual level that includes the actual score for each student. Then, it might be possible for researchers to find evidence of a proximity effect where students attending schools closer to the bombing would have suffered more. This data would likely be highly correlated with the data used in this paper, so similar results would be expected in this future research.

Future research could also compile reports for each demographic group from the MDOE's website rather than use the control variables from the NCES. Thus, instead of controlling for the percent of students in each group for each school, researchers would be able to have the average scores of each control. For example, instead of using the percent of students on free lunch programs as a proxy for the community effects and performed in this paper, pulling the data for students that the MDOE has classified as living in economically disadvantaged areas would provide more specific results as to how these children responded to the bombing.

[6] Statistically significant results are observed for elementary and high school students in downtown Boston and elementary students in the Boston suburbs. The mediation of proximity by grade level, however, is not a focus of this paper and should be examined further in future research. No meaningful results were found after mediating proximity by race or gender.

The findings in this paper should alert all households – not just those in wealthy suburban neighborhoods – that conversing with youth after a traumatic event, such as the Boston Marathon bombing, may create additional adverse consequences. If parents and teachers still feel compelled to do so, they may want to also provide ways to ameliorate any negative effects either at home or in school. Even if parents do not discuss the event with their children directly, they should still continue to check in on their wellbeing; dialogue surrounding the event can be prevalent in a multitude of ways without parents' knowledge – on television, social media and throughout the community – and such discussion can generate traumatic responses. Schools should also make services available to all students in the form of academic and emotional support to weaken the impact of the trauma while students are away from home.

References

Diagnostic and Statistical Manual of Mental Disorders. 5th ed., American Psychiatric Association, 2013.

"Emotional Processing Theory." *APA Dictionary of Psychology,* American Psychological Association. Accessed 4 December 2019

FAQ: Common Reactions to Traumatic Events. MIT Medical, medical.mit.edu/faqs/common-reactions-to-traumatic-events. Accessed 4 December 2019

Ahern, Jennifer, et al. "Television Images and Psychological Symptoms After the September 11 Terrorist Attacks." *Psychiatry: Intepersonal and Biological Processes*, vol. 64, no. 4, 2002, pp. 289–300.

Ahern, Kenneth R. "The Importance of Psychology in Economic Activity: Evidence from Terrorist Attacks." *National Bureau of Economic Research*, Feb. 2018, www.nber.org/papers/w24331.pdf.

Altonji, Joseph G. "The Effects of High School Curriculum on Education and Labor Market Outcomes." The Journal of Human Resources, vol. 30, no. 3, 1995, pp. 409–438.

Anda, Robert F., et al. "The Enduring Effects of Abuse and Related Adverse Experiences in Childhood: A Convergence of Evidence from Neurobiology and Epidemiology." European Archives of Psychiatry and Clinical Neuroscience, 2006, pp. 174-186.

Beauchesne, Michelle A., et al. "Attack on America: Children's Reactions and Parents' Responses." *Journal of Pediatric Health Care*, vol. 16, no. 5, 2002, pp. 213–221.

Becker, Gary. Human Capital: A Theoretical and Empirical Analysis with Special References to Education. 3rd ed., The University of Chicago Press, 1993.

Becker, Gary S., and Yona Rubinstein. "Fear and the Response to Terrorism: An Economic Analysis." *Centre for Economic Performanc*, Sept. 2011, cep.lse.ac.uk/pubs/download/dp1079.pdf.

Becker-Blease, Kathryn A., et al. "Media Exposure Predicts Children's Reactions to Crime and Terrorism." *Journal of Trauma & Dissociation*, vol. 9, no. 2, 2008, pp. 225–248.

Beland, Louis-Philippe, and Dongwoo Kim. "The Effect of High School Shootings on Schools and Student Performance." *Educational Evaluation and Policy Analysis*, vol. 38, no. 1, Mar. 2016, pp. 113–126.

Bell, Carl C., and Esther J. Jenkins. "Traumatic Stress and Children." *Journal of Health Care for the Poor and Underserved*, vol. 2, no. 1, 1991, pp. 175–188.

Bisson, Jonathan I. "Post-Traumatic Stress Disorder." BMJ, 26 Nov. 2015.

Bowen, Natasha K., and Gary L. Bowen. "Effects of Crime and Violence in Neighborhoods and Schools on the School Behavior and Performance of Adolescents." Journal of Adolescent Research, 1 July 1999.

Bremner, J. Douglas. "Traumatic Stress: Effects on the Brain." Dialogues in Clinical Neuroscience, vol. 8, no. 4, Dec. 2008, pp. 445–461.

Card, David, and Alan B. Krueger. "Does School Quality Matter? Returns to Education and the Characteristics of Public Schools in the United States." The Journal of Political Economy, vol. 100, no. 1, Feb. 1992, pp. 1–40.

Card, David, and Alan B. Krueger. "School Resources and Student Outcomes: An Overview of the Literature and New Evidence from North and South Carolina." Journal of Economic Perspectives, vol. 10, no. 4, 1996, pp. 31–50.

Copeland, William E., et al. "Traumatic Events and Posttraumatic Stress in Childhood." *Archives of General Psychiatry*, vol. 64, May 2007, pp. 577–584.

Currie, Janet and Mark Stabile. "Mental Health in Childhood and Human Capital." The Problems of Disadvantaged Youth: An Economic Perspective, University of Chicago Press, 2009, pp. 115–148.

Diette, Timothy M., et al. "Violence Victimization: Are there Racial Differences in Prevalence and Association with Subsequent Educational Attainment, Mental Health Status, and Substance Abuse? February 2020.

Finkelhor, David, and Angela Browne, 1985. "The Traumatic Impact of Child Sexual Abuse: A Conceptualization." American Journal of Orthopsychiatry, 55(4), pp. 530-541.

Finucane, Martin. "Globe Wins Pulitzer for Breaking News Coverage of Boston Marathon Bombings." Boston Globe, 15 Apr. 2014.

Garcia-Vera, Maria Paz, et al. "A Systematic Review of the Literature on Posttraumatic Stress Disorder in Victims of Terrorist Attacks." *Psychological Reports*, vol. 119, July 2016, pp. 328–359.

Gershenson, Seth, and Erdal Tekin. "The Effect of Community Traumatic Events on Student Achievement: Evidence from the Beltway Sniper Attacks." *National Bureau of Economic Research*, Mar. 2015, www.nber.org/papers/w21055.pdf.

Grossman, Michael. "On the Concept of Health Capital and the Demand for Health." Journal of Political Economy, vol. 80, no. 2, 1972, pp. 223–255.

Grossman, Michael. "The Human Capital Model of the Demand for Health." Handbook of Health Economics, 1999.

Halpern-Felsher, Bonnie L., and Susan G. Millstein. "The Effects of Terrorism on Teens' Perceptions of Dying: The New World Is Riskier Than Ever." *Journal of Adolescent Health*, vol. 30, no. 5, May 2002, pp. 308–311.

Iribarren, Javier. “Post-Traumatic Stress Disorder: Evidence-Based Research for the Third Millennium.” Evidence Based Complementary and Alternative Medicine, vol. 2, no. 4, Dec. 2005, pp. 503–512.

Janoff-Bulman, Ronnie. *Shattered Assumptions: Towards a New Psychology of Trauma*. Free Press, 1992.

Kataoka, Sheryl, et al. “Effects on School Outcomes in Low-Income Minority Youth: Preliminary Findings from a Community-Partnered Study of a School Trauma Intervention.” *National Center for Biotechnology Information*, 2011, www.ncbi.nlm.nih.gov/pmc/articles/PMC3287975/.

Kataoka, Sheryl, et al. “Responding to Students with PTSD in Schools.” *Child and Adolescent Psychiatric Clinics of North America*, vol. 21, no. 1, Jan. 2012, pp. 119–133.

Koedel, Cory and Julian R. Betts. “Re-Examining the Role of Teacher Quality In the Educational Production Function.” 2007.

Krueger, Alan. “Experimental Estimates of Education Production Functions.” The Quarterly Journal of Economics, vol. 114, no. 2, May 1999, pp. 497–532.

Lazar, Kay, and Sarah Schweitzer. “A Year since Marathon Attacks, Many of Wounded Struggle.” Boston Globe, 15 Apr. 2014.

Lee, Traci G. “The Real Story of Sunil Tripathi, the Boston Bomber Who Wasn't.” *NBCNews.com*, NBCUniversal News Group, 22 June 2015, www.nbcnews.com/news/asian-america/wrongly-accused-boston-bombing-sunil-tripathys- story-now-being-told-n373141.

Lemola, Sakari, et al. “Media Use and Insomnia After Terror Attacks in France.” *Journal of Psychiatric Research*, vol. 98, Mar. 2018, pp. 47–50.

Macmillan, Ross and John Hagan, 2004. “Violence in the Transition to Adulthood: Adolescent Victimization, Education, and Socioeconomic Attainment in Later Life.” Journal of Research on Adolescence, 14(2), pp. 127–158.

Margolin, Gayla, and Elana B. Gordis. “The Effects of Family and Community Violence on Children.” *National Center for Biotechnology Information*, 2000, www.annualreviews.org/doi/pdf/10.1146/annurev.psych.51.1.445.

Mueller, C. M., and C. S. Dweck. “Praise for Intelligence Can Undermind Children's Motivation and Performance.” Journal of Personality and Social Psychology, 2012, pp. 33–52.

Olff, Miranda. “Sex and Gender Differences in Post-Traumatic Stress Disorder: An Update.” *European Journal of Psychotraumatology*, vol. 8, no. 4, 2017.

Singh, Amika, et al. “Physical Activity and Performance at School.” Arch Pediatr Adolesc Med, 2012.

Suvak, Michael, et al. “Indirect Exposure to the September 11 Terrorist Attacks: Does Symptom Structure Resemble PTSD?” *Journal of Traumatic Stress*, vol. 21, no. 1, Feb. 2008, pp. 30–39.

Teicher, Martin H., et al. “Developmental Neurobiology of Childhood Stress and Trauma.” Psychiatric Clinics of North America, vol. 25, no. 2, 2002, pp. 397-426.

Utzon-Frank, Nicolai, et al. “ Occurrence of Delayed-Onset Post-Traumatic Stress Disorder: a Systematic Review and Meta-Analysis of Prospective Studies.” Scandinavian Journal of Work, Environment & Health, vol. 40, no. 3, May 2014, pp. 215–229.

“What Is Posttraumatic Stress Disorder?” American Psychiatric Association, www.psychiatry.org/patients-families/ptsd/what-is-ptsd.

Appendix A

Figure 1: Education Production Function

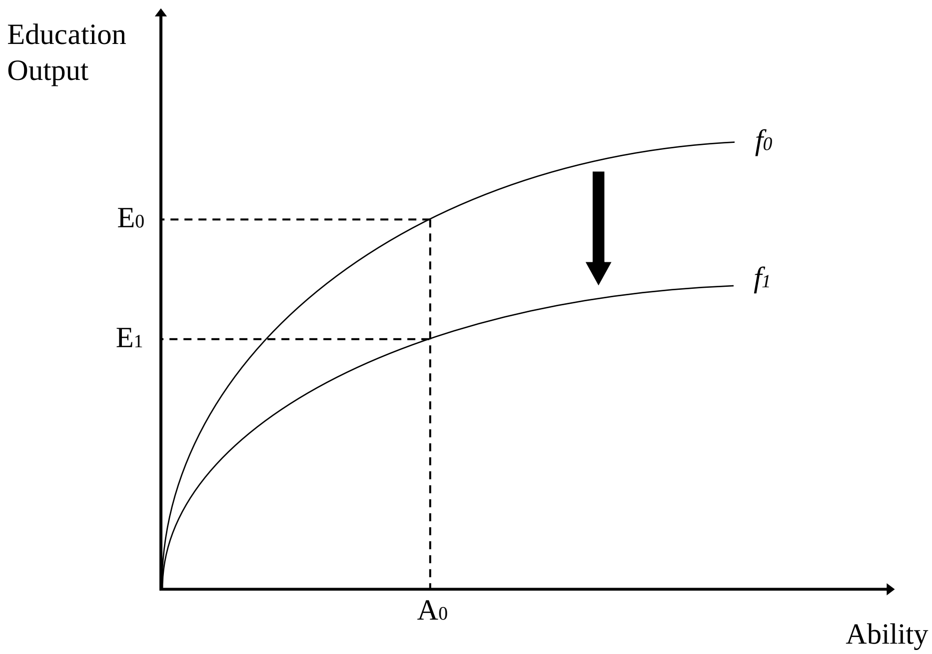


Figure 2: Education Production Function by Proximity – Short Run Effect

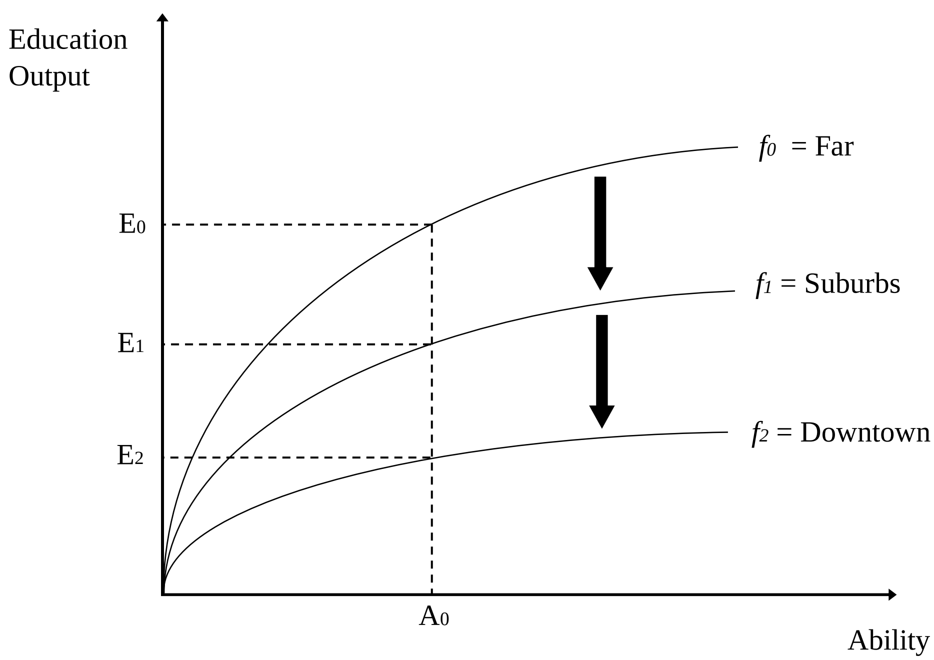


Figure 3: Education Production Function by Proximity – Intermediate Run Effect

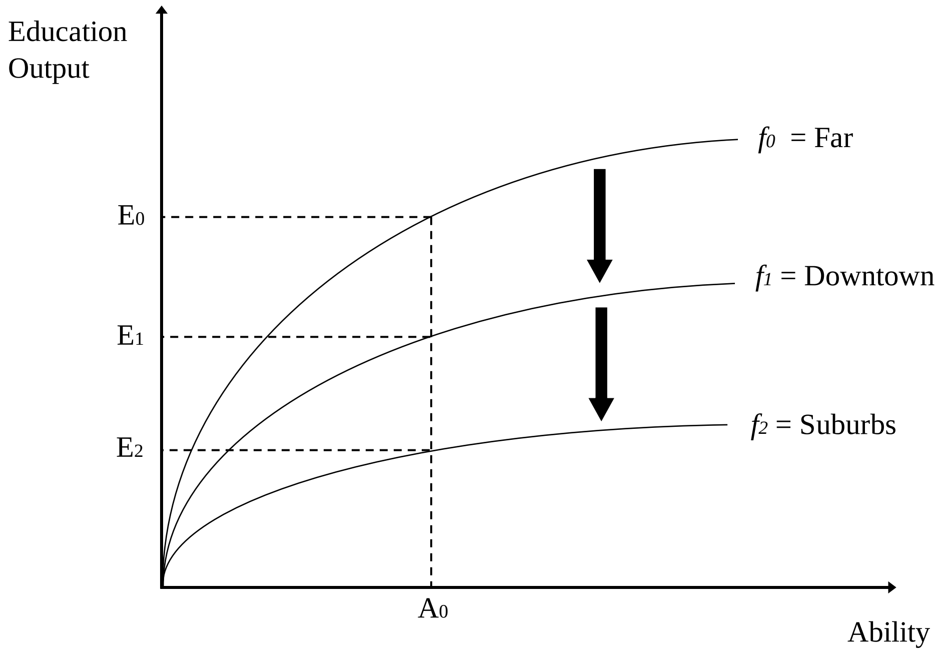
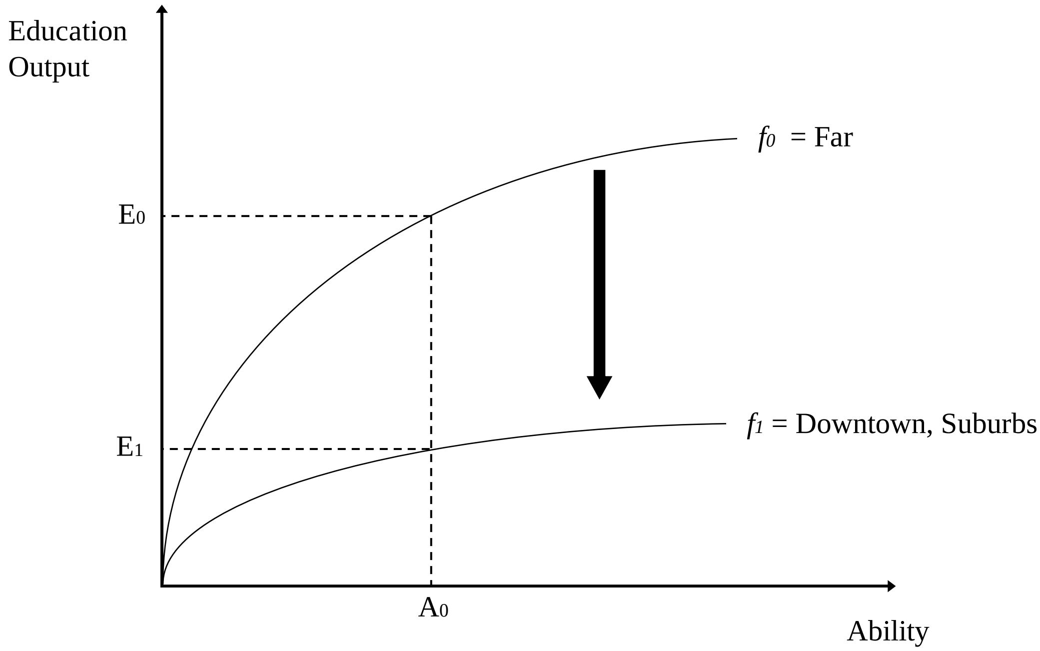


Figure 4: Long Run Effect Outcomes

		Short Run Effect	
		Yes	No
Intermediate Run Effect	Yes	Long Run Effect	Potential Long Run Effect (Greater for Lower Proximity)
	No	Potential Long Run Effect (Greater for Higher Proximity)	No Long Run Effect

Figure 5: Education Production Function by Proximity – Long Run Effect



Appendix B

Table 1: Summary Statistics for Dependent and Key Independent Variables

	2011	2012	2013	2014	2015
Panel A: Test Scores					
Mean	72.29	70.57	73.03	72.76	73.18
Standard Deviation	8.46	9.06	8.65	8.61	8.03
# of Observations	1,392	1,367	1,420	1,404	787
Panel B: Distance					
Mean	52.20	52.20	52.71	52.70	54.04
Standard Deviation	43.21	43.38	43.27	43.26	42.85
# of Observations	1,392	1,367	1,420	1,404	787
Panel C: Distance by Proximity Category					
Downtown:					
Mean	6.15	6.13	6.12	6.10	5.76
Standard Deviation	2.50	2.49	2.49	2.49	2.49
# of Observations	176	177	179	177	74
Suburbs:					
Mean	21.81	21.81	21.82	21.86	20.51
Standard Deviation	7.00	7.04	7.00	7.01	6.53
# of Observations	436	426	434	429	225
Outside:					
Mean	79.58	79.82	79.66	79.61	76.82
Standard Deviation	39.47	39.59	39.31	39.33	39.35
# of Observations	780	764	807	798	488

Table 2: Summary Statistics for Control Variables

	2011	2012	2013	2014	2015
Panel A: Free Lunch					
Mean	0.32	0.33	0.32	0.32	0.30
Standard Deviation	0.27	0.27	0.27	0.27	0.26
# of Observations	1,392	1,367	1,420	1,404	787
Panel B: Expenditure per Pupil					
Mean	14,276.30	14,280.03	14,284.41	14,297.30	14,275.71
Standard Deviation	2,690.03	2,690.71	2,721.41	2,742.49	2,982.09
# of Observations	1,330	1,305	1,354	1,341	751
Panel C: Grade by Grade Level					
Elementary					
Mean	3.74	4.45	3.92	3.90	3.98
Standard Deviation	0.83	0.50	0.83	0.80	0.77
# of Observations	808	753	813	814	349
Middle School					
Mean	6.89	6.97	7.01	7.00	6.96
Standard Deviation	0.81	0.82	0.80	0.82	0.82
# of Observations	332	359	348	334	164
High School					
Mean	10	10	10	10	10
Standard Deviation	0	0	0	0	0
# of Observations	252	255	259	256	274
Panel D: Race					
White					
Mean	0.67	0.66	0.67	0.67	0.69
Standard Deviation	0.29	0.29	0.29	0.29	0.28
# of Observations	1,392	1,367	1,420	1,404	787
Black					
Mean	0.08	0.08	0.08	0.08	0.07
Standard Deviation	0.13	0.13	0.13	0.13	0.12
# of Observations	1,392	1,367	1,420	1,404	787
Panel E: Gender					
Female					
Mean	0.49	0.49	0.49	0.49	0.49
Standard Deviation	0.03	0.04	0.04	0.03	0.04
# of Observations	1,392	1,367	1,420	1,404	787

Figure 1: Average Scores by Year

Figure 2: Average Score by Proximity

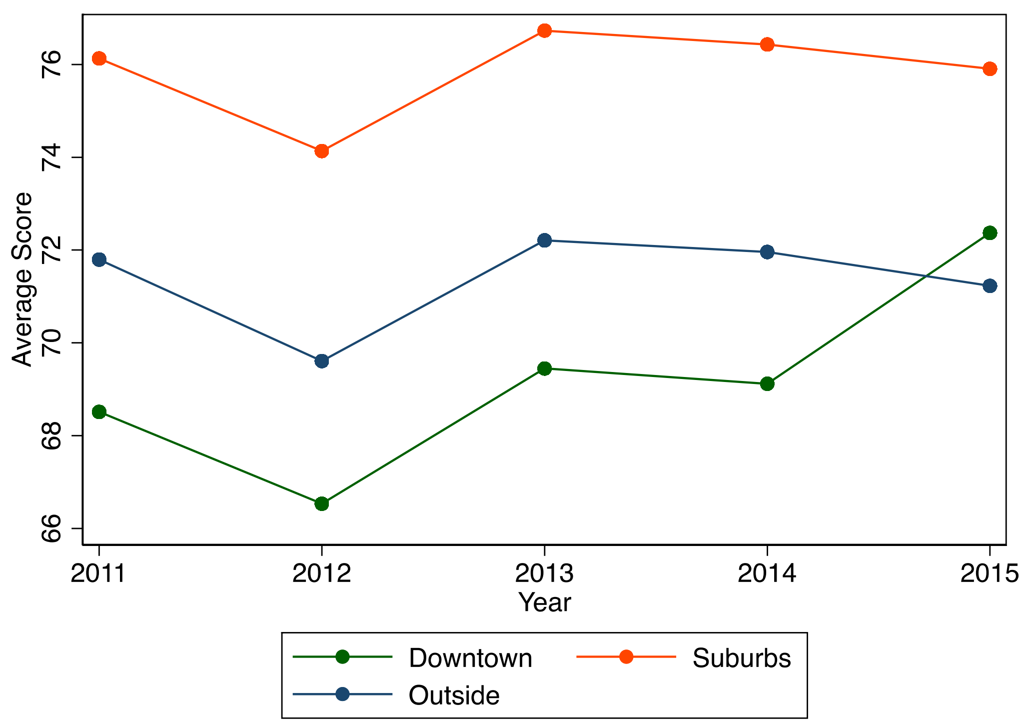


Figure 3: Average Score by Free Lunch

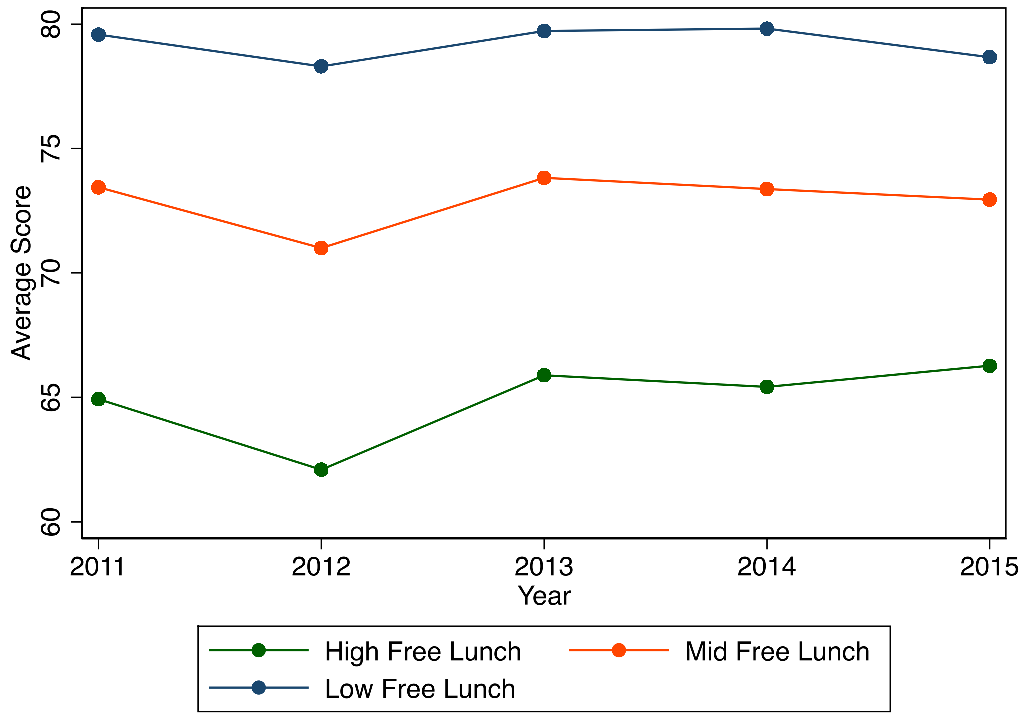


Figure 4: Average Score by Proximity – Free Lunch

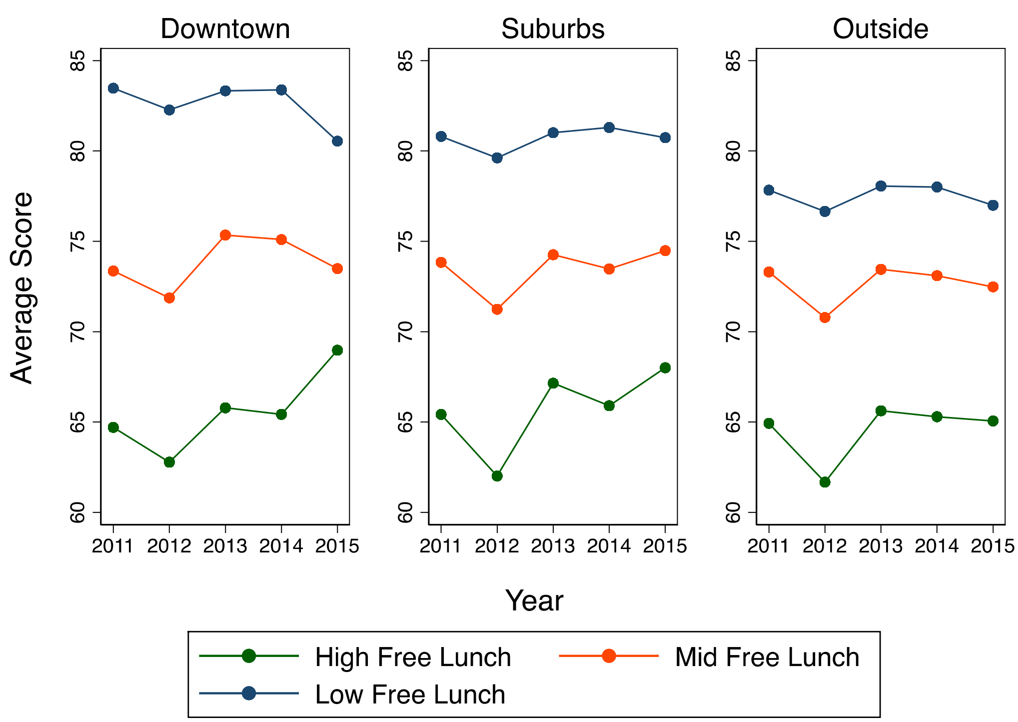


Figure 5: Average Score by Expenditures per Pupil

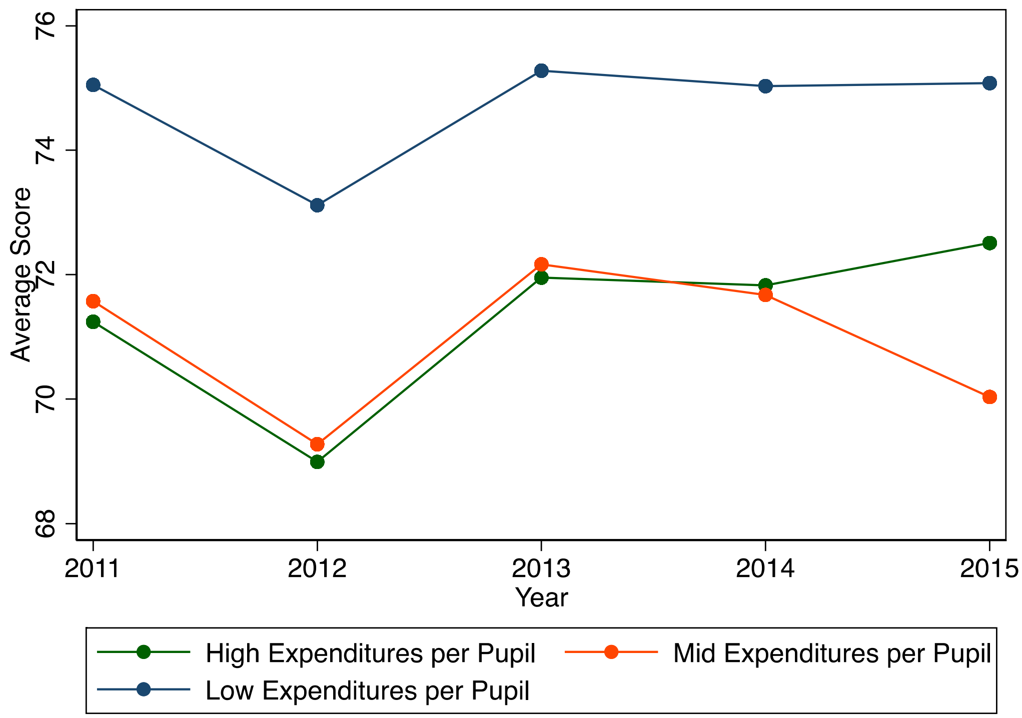
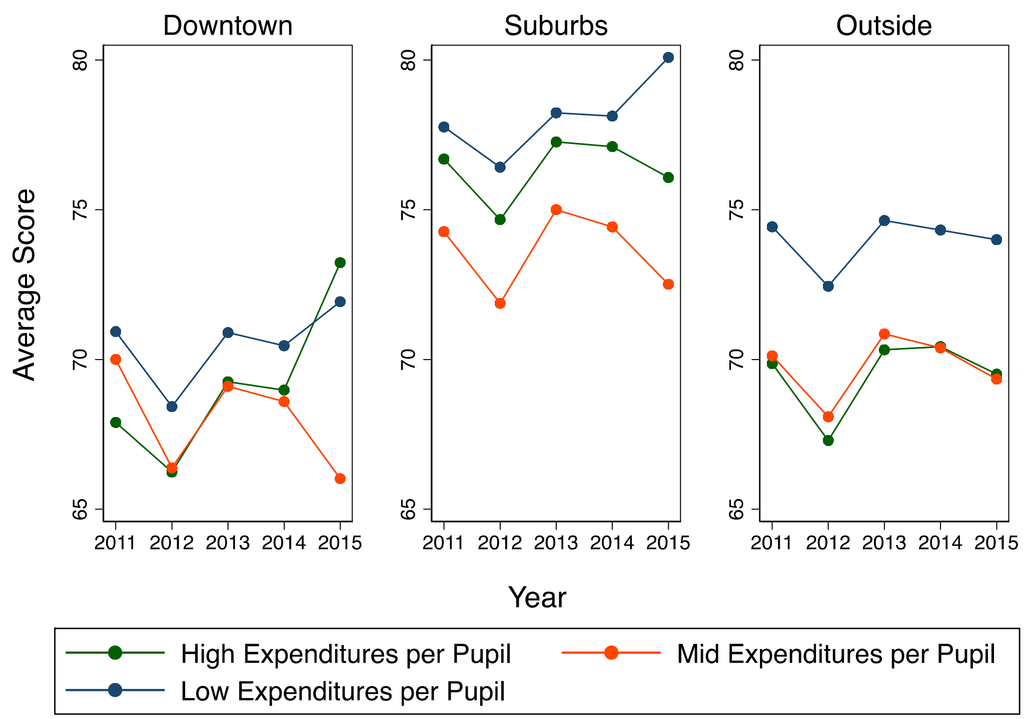


Figure 6: Average Score by Proximity – Expenditures per Pupil



Appendix C

Table 1: Difference Models

VARIABLES	(1) 2013-2012	(2) 2014-2013	(3) 2014-2012
Downtown	-0.241	0.325	-0.441
	(0.346)	(0.316)	(0.504)
Suburb	-0.0289	0.106	-0.0163
	(0.220)	(0.173)	(0.264)
Elementary School	2.869***	-1.154***	1.875***
	(0.199)	(0.156)	(0.258)
High School	0.565**	-1.198***	-0.843***
	(0.229)	(0.217)	(0.281)
Low % Free Lunch	-1.157***	0.471**	-0.692**
	(0.235)	(0.185)	(0.286)
High % Free Lunch	0.271	0.174	0.518
	(0.388)	(0.285)	(0.565)
Low Expenditures	-0.420*	-0.0339	-0.296
	(0.230)	(0.177)	(0.283)
High Expenditures	-0.124	0.143	0.271
	(0.253)	(0.197)	(0.303)
Low % Female	0.106	-0.0597	0.00306
	(0.189)	(0.149)	(0.236)
Low % White	1.333***	-0.192	1.292**
	(0.434)	(0.303)	(0.563)
High % White	-0.592*	-0.0116	-0.420
	(0.311)	(0.223)	(0.376)
Low % Black	0.284	0.0370	0.153
	(0.257)	(0.182)	(0.306)
High % Black	-0.858***	-0.174	-0.537
	(0.284)	(0.219)	(0.364)
Low % Hispanic	0.360	0.0265	0.293
	(0.248)	(0.194)	(0.301)
High % Hispanic	-0.166	0.0439	-0.538
	(0.336)	(0.247)	(0.464)
Low % Asian	0.173	-0.00489	-0.0488
	(0.241)	(0.197)	(0.307)
High % Asian	-0.920***	-0.109	-1.013**
	(0.342)	(0.233)	(0.451)
Constant	0.962***	0.324	1.421***
	(0.333)	(0.265)	(0.442)
Observations	1,076	1,389	1,084
R-squared	0.242	0.045	0.129

Robust standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 2: Additional School Effects

VARIABLES	(1) 2011	(2) 2012	(3) 2013	(4) 2014	(5) 2015
Downtown	2.596**	2.256*	1.788	0.586	-3.769**
	(1.122)	(1.162)	(1.276)	(1.573)	(1.579)
Suburbs	0.689	0.446	0.648	0.306	0.309
	(0.564)	(0.597)	(0.536)	(0.524)	(0.847)
Low Expenditures	0.444	0.182	-0.0576	-0.299	-0.347
	(0.427)	(0.449)	(0.427)	(0.416)	(0.563)
High Expenditures	-0.110	-0.627	-0.354	-0.279	0.142
	(0.576)	(0.620)	(0.596)	(0.586)	(0.753)
Low Expenditures x	-0.664	0.0545	0.296	1.752	3.307
Downtown	(1.347)	(1.493)	(1.520)	(1.762)	(2.995)
High Expenditures x	-1.229	0.218	0.0886	1.406	5.725***
Downtown	(1.363)	(1.393)	(1.473)	(1.757)	(1.980)
Low Expenditures x Suburbs	-0.0572	0.526	0.186	0.784	2.128**
	(0.659)	(0.730)	(0.670)	(0.649)	(0.982)
High Expenditures x Suburbs	1.345*	1.333	1.088	1.549**	1.371
	(0.804)	(0.893)	(0.807)	(0.789)	(1.138)
Constant	73.58***	71.93***	72.97***	73.80***	72.55***
	(0.569)	(0.606)	(0.609)	(0.600)	(0.778)
Controls	x	x	x	x	x
Observations	1,350	1,367	1,420	1,404	787
R-squared	0.641	0.630	0.628	0.628	0.567

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Controls include elementary school, high school, low % free lunch, high % free lunch, low % female, low % white, high % white, low % black, high % black, low % Hispanic, high % Hispanic, low % Asian, high % Asian

Table 3: Additional Community Effects

VARIABLES	(1) 2011	(2) 2012	(3) 2013	(4) 2014	(5) 2015
Downtown	0.688	1.164	1.887*	1.490	-1.322
	(1.100)	(1.057)	(1.060)	(1.201)	(1.675)
Suburbs	0.149	0.0213	0.256	0.0784	1.362*
	(0.494)	(0.547)	(0.517)	(0.520)	(0.713)
Low % Free Lunch	3.666***	4.786***	3.871***	3.946***	3.553***
	(0.370)	(0.432)	(0.376)	(0.396)	(0.509)
High % Free Lunch	-5.420***	-6.273***	-5.630***	-5.315***	-4.309***
	(0.647)	(0.704)	(0.643)	(0.680)	(0.851)
Low % Free Lunch x Downtown	2.589*	2.019	1.021	1.727	4.338**
	(1.360)	(1.495)	(1.449)	(1.554)	(2.158)
High % Free Lunch x Downtown	0.417	1.006	-0.382	-0.395	2.351
	(1.324)	(1.266)	(1.262)	(1.409)	(2.111)
Low % Free Lunch x Suburbs	1.886***	1.993***	1.161*	2.008***	0.571
	(0.570)	(0.650)	(0.592)	(0.604)	(0.850)
High % Free Lunch x Suburbs	0.483	0.409	1.431	0.362	-0.707
	(1.060)	(1.194)	(1.074)	(1.023)	(1.366)
Constant	73.78***	72.05***	72.96***	73.61***	72.14***
	(0.549)	(0.603)	(0.573)	(0.565)	(0.766)
Controls	X	X	X	X	X
Observations	1,350	1,367	1,420	1,404	787
R-squared	0.642	0.631	0.629	0.630	0.564

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Controls include elementary, high school, low expenditures, high expenditures, low % female, low % white, high % white, low % black, high % black, low % Hispanic, high % Hispanic, low % Asian, high % Asian

Table 4: Grade Level

VARIABLES	(1) 2011	(2) 2012	(3) 2013	(4) 2014	(5) 2015
Downtown	2.643**	2.456**	3.930***	4.375***	2.110
	(1.140)	(1.054)	(1.106)	(1.096)	(2.290)
Suburbs	1.143*	1.057	1.846***	1.745***	0.682
	(0.644)	(0.654)	(0.637)	(0.597)	(1.088)
Elementary School	3.250***	2.877***	6.204***	4.856***	5.532***
	(0.440)	(0.484)	(0.512)	(0.490)	(0.649)
High School	-4.634***	-4.038***	-2.380***	-3.547***	4.002***
	(0.483)	(0.543)	(0.576)	(0.569)	(0.683)
Elementary x Downtown	-2.416*	-1.130	-2.813**	-3.966***	-2.146
	(1.297)	(1.185)	(1.194)	(1.260)	(2.420)
High School x Downtown	0.628	2.139	-3.594**	-3.558**	-1.293
	(1.590)	(1.677)	(1.829)	(1.603)	(2.718)
Elementary x Suburbs	-0.485	-0.748	-1.410**	-1.220*	0.884
	(0.722)	(0.764)	(0.709)	(0.670)	(1.210)
High School x Suburbs	0.958	1.844*	0.0606	-0.188	0.863
	(0.844)	(0.981)	(0.914)	(0.908)	(1.270)
Constant	73.33***	71.69***	72.29***	72.92***	71.99***
	(0.569)	(0.619)	(0.631)	(0.615)	(0.793)
Controls	x	x	x	x	x
Observations	1,350	1,367	1,420	1,404	787
R-squared	0.643	0.632	0.631	0.632	0.562

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Controls include low % free lunch, high % free lunch, low expenditure, high expenditure, low % female, low % white, high % white, low % black, high % black, low % Hispanic, high % Hispanic, low % Asian, and high % Asian

Table 5: Additional Gender Effects

VARIABLES	(1) 2011	(2) 2012	(3) 2013	(4) 2014	(5) 2015
Downtown	2.429***	3.296***	2.515***	2.235***	2.708**
	(0.792)	(0.781)	(0.768)	(0.771)	(1.283)
Suburbs	1.102***	1.338***	1.107***	1.073***	1.898***
	(0.412)	(0.467)	(0.417)	(0.409)	(0.539)
Low % Female	-1.245***	-1.399***	-1.488***	-1.533***	-1.349***
	(0.381)	(0.415)	(0.393)	(0.387)	(0.491)
Low % Female x Downtown	-2.148**	-2.155**	-1.661	-1.315	-4.232**
	(1.082)	(1.050)	(1.036)	(1.105)	(1.739)
Low % Female x Suburbs	-0.0306	-0.590	-0.131	-0.0585	-1.011
	(0.571)	(0.644)	(0.579)	(0.572)	(0.826)
Constant	73.35***	71.43***	72.67***	73.37***	71.55***
	(0.557)	(0.615)	(0.575)	(0.568)	(0.773)
Controls	x	x	x	x	x
Observations	1,350	1,367	1,420	1,404	787
R-squared	0.641	0.631	0.628	0.628	0.567

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Controls include elementary school, high school, low % free lunch, high % free lunch, low expenditure, high expenditure, low % white, high % white, low % black, high % black, low % Hispanic, high % Hispanic, low % Asian, high % Asian

Table 6: Additional Race Effects – White Students

VARIABLES	(1) 2011	(2) 2012	(3) 2013	(4) 2014	(5) 2015
Downtown	1.408	1.280	1.093	1.524	-0.682
	(0.986)	(1.015)	(0.968)	(1.171)	(1.522)
Suburbs	0.775*	1.037**	0.774	1.177**	1.430**
	(0.460)	(0.509)	(0.476)	(0.477)	(0.579)
Low % White	-3.710***	-3.760***	-2.978***	-2.372***	-1.189
	(0.897)	(0.927)	(0.928)	(0.910)	(1.115)
High % White	-1.048**	-0.515	-1.469***	-1.255**	-0.765
	(0.521)	(0.569)	(0.491)	(0.489)	(0.606)
Low % White x Downtown	0.120	1.375	1.039	0.0572	1.953
	(1.299)	(1.306)	(1.289)	(1.445)	(1.976)
High % White x Downtown	-1.706	-3.304***	-0.744	-1.258	-8.314***
	(2.345)	(1.104)	(2.007)	(2.071)	(1.585)
Low % White x Suburbs	0.702	0.162	1.017	-0.385	-0.619
	(1.065)	(1.167)	(1.055)	(1.013)	(1.297)
High % White x Suburbs	0.401	-0.221	0.0824	-0.149	0.494
	(0.573)	(0.658)	(0.571)	(0.573)	(0.815)
Constant	73.70***	71.84***	73.02***	73.46***	72.15***
	(0.588)	(0.637)	(0.601)	(0.599)	(0.791)
Controls	x	x	x	x	x
Observations	1,350	1,367	1,420	1,404	787
R-squared	0.640	0.630	0.628	0.627	0.564

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Controls include elementary school, high school, low % free lunch, high % free lunch, low expenditure, high expenditure, low % female, low % black, high % black, low % Hispanic, high % Hispanic, low % Asian, high % Asian

Table 7: Additional Race Effects – Black Students

VARIABLES	(1) 2011	(2) 2012	(3) 2013	(4) 2014	(5) 2015
Downtown	3.189***	3.402***	2.908***	3.010***	0.275
	(0.787)	(0.822)	(0.856)	(0.891)	(1.661)
Suburbs	1.012**	0.962**	0.542	0.884**	0.589
	(0.435)	(0.481)	(0.447)	(0.439)	(0.576)
Low % Black	0.269	0.413	0.401	0.503	-0.415
	(0.458)	(0.492)	(0.439)	(0.446)	(0.505)
High % Black	-0.500	-0.480	-2.062***	-1.458**	-2.321***
	(0.704)	(0.728)	(0.739)	(0.731)	(0.884)
Low % Black x Downtown	-4.432***	-4.357	-5.575***	-3.237**	-3.043
	(1.341)	(2.658)	(1.513)	(1.305)	(4.631)
High % Black x Downtown	-2.543**	-1.588	-1.146	-1.856	0.785
	(1.141)	(1.160)	(1.204)	(1.232)	(2.013)
Low % Black x Suburbs	0.345	0.182	0.134	0.160	1.703*
	(0.603)	(0.679)	(0.605)	(0.611)	(0.878)
High % Black x Suburbs	-0.0971	0.0839	1.679*	0.415	1.083
	(0.856)	(0.958)	(0.909)	(0.870)	(1.103)
Constant	73.36***	71.61***	72.73***	73.34***	72.25***
	(0.551)	(0.607)	(0.581)	(0.578)	(0.787)
Controls	x	x	x	x	x
Observations	1,350	1,367	1,420	1,404	787
R-squared	0.642	0.630	0.630	0.628	0.563

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Controls include elementary school, high school, low % free lunch, high % free lunch, low expenditure, high expenditure, low % female, low % white, high % white, low % Hispanic, high % Hispanic, low % Asian, high % Asian

Table 8 Additional Race Effects – Hispanic Students

VARIABLES	(1) 2011	(2) 2012	(3) 2013	(4) 2014	(5) 2015
Downtown	1.231	1.795**	1.928**	1.626*	-0.311
	(0.792)	(0.891)	(0.830)	(0.883)	(1.229)
Suburbs	0.0405	-0.203	0.244	0.823*	0.820
	(0.471)	(0.522)	(0.471)	(0.468)	(0.647)
Low % Hispanic	0.781*	0.603	1.157***	1.244***	0.663
	(0.402)	(0.465)	(0.396)	(0.391)	(0.501)
High % Hispanic	-2.087***	-1.617**	-2.018***	-1.157*	-2.626***
	(0.643)	(0.713)	(0.649)	(0.698)	(0.823)
Low % Hispanic x Downtown	-0.657	-2.042	-1.376	-0.270	2.949
	(1.829)	(1.869)	(1.534)	(1.821)	(1.959)
High % Hispanic x Downtown	0.407	0.767	-0.0686	-0.118	1.462
	(1.122)	(1.160)	(1.125)	(1.195)	(1.886)
Low % Hispanic x Suburbs	1.208**	1.676***	0.801	0.484	0.986
	(0.556)	(0.635)	(0.550)	(0.556)	(0.780)
High % Hispanic x Suburbs	2.409**	2.355**	2.332**	0.102	0.594
	(1.054)	(1.182)	(1.060)	(1.012)	(1.272)
Constant	74.00***	72.31***	73.11***	73.57***	72.28***
	(0.573)	(0.621)	(0.582)	(0.576)	(0.783)
Controls	x	x	x	x	x
Observations	1,350	1,367	1,420	1,404	787
R-squared	0.642	0.632	0.629	0.627	0.562

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Controls include elementary school, high school, low % free lunch, high % free lunch, low expenditure, high expenditure, low % female, low % white, high % white, low % black, high % black, low % Asian, high % Asian

Table 9: Additional Race Effects – Asian Students

VARIABLES	(1) 2011	(2) 2012	(3) 2013	(4) 2014	(5) 2015
Downtown	1.827**	1.799**	2.435***	2.874***	1.302
	(0.807)	(0.765)	(0.815)	(0.807)	(1.468)
Suburbs	1.532***	1.232**	1.982***	2.010***	1.245*
	(0.576)	(0.626)	(0.591)	(0.554)	(0.729)
Low % Asian	-1.236**	-1.773***	-0.816	-1.078**	-2.442***
	(0.545)	(0.580)	(0.579)	(0.529)	(0.715)
High % Asian	3.583***	4.244***	5.150***	4.354***	2.186**
	(0.857)	(0.947)	(0.952)	(0.838)	(1.077)
Low % Asian x Downtown	-1.004	0.668	-1.254	-2.031	-4.693*
	(1.277)	(1.208)	(1.228)	(1.304)	(2.566)
High % Asian x Downtown	0.642	0.822	-1.237	-2.277	1.130
	(1.491)	(1.650)	(1.505)	(1.527)	(1.975)
Low % Asian x Suburbs	-0.717	-0.311	-1.295*	-1.425**	1.148
	(0.688)	(0.764)	(0.714)	(0.670)	(0.932)
High % Asian x Suburbs	-0.132	-0.778	-2.491**	-1.596	-1.787
	(1.058)	(1.206)	(1.133)	(1.035)	(1.386)
Constant	73.26***	71.74***	72.25***	72.79***	71.71***
	(0.625)	(0.655)	(0.668)	(0.644)	(0.790)
Controls	x	x	x	x	x
Observations	1,350	1,367	1,420	1,404	787
R-squared	0.640	0.629	0.629	0.629	0.574

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Controls include elementary school, high school, low % free lunch, high % free lunch, low expenditure, high expenditure, low % female, low % white, high % white, low % black, high % black, low % Hispanic, high % Hispanic